

REMARKS

This is in response to the Office Action mailed on April 29, 2004, and the references cited therewith.

Claims 1, 9, 14, 22, 30 and 51 are amended, no claims are canceled, and no claims are added; as a result, claims 1, 2, 4-10, 12-15, 17-23, are now pending in this application.

§112 Rejection of the Claims

Claims 1-2, 4, 14-15, 17, 51-52 and 54-56 were rejected under 35 U.S.C. § 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. Specifically, the outstanding Office Action noted the previous amendment of a single element metal layer as not in strict agreement with the specification, which states that the metal is 99.9999% pure. Applicant respectfully disagrees with this rejection. Applicant submits that one of skill in the art would know that the noted figure is the value given as the guaranteed purity of evaporation targets, and is thus the best purity value for what would generally be understood in the art to mean that a material was a single element. To advance the prosecution of the present application, Applicant has amended the claims in accordance with the direction of the outstanding Office Action by adding that the metal is substantially a single element. Therefore, Applicant respectfully requests withdrawal of this rejection.

§103 Rejection of the Claims

Claims 1-2, 4, 14-15, 17, 51-52 and 54-56 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Maiti (U.S. 6,020,024) in view of Park (U.S. 5,795,808) and Brasen (U.S. 4,725,877) and Ma (U.S. 6,207,589). Applicant respectfully traverses the rejection.

Maiti is seen as teaching a high dielectric constant metal oxide layer on a silicon nitride layer grown on the surface of a semiconductor wafer by either ion implantation of nitrogen ions, thermal nitridation of a thin oxide layer, or plasma/thermal processing. Applicant respectfully submits that the structure of the present claimed invention is different from Maiti. For example, Maiti includes a silicon nitride layer 14 between the high k metal oxide 16 and the substrate 12.

Such a layer does not exist in the claimed invention and is a problem, as discussed clearly in Maiti at least at column 2, lines 5-10, and line 25, and column 3, lines 23-29. Maiti appears to understand the problem with the layer 14 causing greatly reduced capacitance because of the series connection of the relatively low k value of the nitride with respect to the high k metal oxide 16. However, Maiti apparently does not know what to do about this problem, since Maiti uses extremely energetic methods of forming the metal oxide 16, such as sputtering, which are known to cause surface damage and poor dielectric properties. This is one of the problems disclosed in the present specification, and is one of the reasons why the claimed invention is not obvious over Maiti, even ignoring the differences in physical structure and electrical behavior. Essentially, the different physical structure and poorer electrical results of Maiti teaches away from the present claims because Maiti discusses the series capacitance problem in its specification.

In view of the above differences of Maiti from the structures and methods of the present claims, Applicant respectfully submits that Maiti does not teach all of the positive steps of the present claims, such as evaporation deposition, oxidation of the metal, a single element, and use of electron beams, as stated in the outstanding Office Action. Applicant further submits that the claimed structure is different in at least one significant way from Maiti in not having the problematic silicon nitride layer under the high k metal oxide layer.

The outstanding Office Action uses the cited Park reference and the cited Brasen reference to supply Maiti's missing feature of electron beam evaporation. Park teaches ion implantation into the metal layer to form the source and drain regions (see column 3, line 16) and has two different metal films that form two metal silicides (see column 3, line 23)--a feature specifically noted in the present application as a problem to be avoided. Brasen teaches titanium silicon intermetallic materials for low contact resistance (see column 2, line 23). Applicant cannot find any teaching in the cited portions of Brasen about metal oxides for gate dielectrics. Applicant respectfully submits Park and Brasen do nothing to cure the above noted failures of Maiti to teach the structure of the present claims.

Ma is used to show the missing feature of Maiti of an amorphous metal oxide layer. Ma discloses an oxide layer and an oxidation barrier below the aluminum doped zirconium oxide layer. Applicant therefore respectfully submits that Ma does nothing to cure the above noted

shortcomings of Maiti, especially regarding the method of making the device, and the device structure. Even when Ma is combined with Maiti, there is still at least the problem of the series capacitance gate dielectric structure.

Because the cited references, whether taken alone or in any combination with each other, fail to describe either the structure or the method of making the claimed invention, Applicant respectfully requests withdrawal of this rejection.

Claims 22-23, 25, 30-31 and 33 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Maiti in view of alleged admitted prior art (pages 1-4) in view of Park and Brasen and Ma. Applicant respectfully traverses this rejection.

Maiti does not teach the positive elements of the present claims, as discussed above. The Office Action uses the alleged Applicant's Admitted Prior Art (AAPA) to show that it is well known in the art to use the metal oxide layer to form ICs, processors, mobile telephones and memory devices, including wordlines, sourcelines, bitlines and system busses. However, the alleged AAPA does not correct the above noted deficiencies of Maiti and the other cited references, or their failure to teach either the structure of the claimed invention, or to obtain the electrical results of the claimed arrangement. This is true for many of the same reasons given above with reference to the prior rejection of the other claims in issue.

Because the cited references, whether taken alone or in any combination, do not describe or suggest the above noted features of the present claims, Applicant respectfully requests withdrawal of this rejection.

Claims 5-7, 18-20, 26-28 and 34-36 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Maiti in view of the admitted prior and Park and Brasen and Ma as applied to claims 1, 14 and 30, and further in view of Yano (U.S. 5,810,923). Applicant respectfully traverses this rejection.

The features of the cited references have been discussed above, except the cited reference of Yano. Yano is used in the outstanding Office Action to show that electron beam evaporation of zirconium oxide at substrate temperatures on 300-700 deg C is known. Applicant respectfully submits that the deposition of a metal oxide in Yano is dissimilar from (and fails to teach) the

present application's deposition of a metal that is then oxidized. Nor is there any teaching or disclosure in Yano to cure the deficiencies of Maiti discussed above. Therefore, Applicant respectfully requests withdrawal of this rejection.

Claims 8-10, 12-13 and 21 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Maiti in view of Park, Brasen, and Ma, and further in view of Moise (U.S. 6,211,035) and Yano. Applicant respectfully traverses this rejection.

The features of the cited references have been discussed above, except the cited reference of Moise. Moise teaches about capacitors such as paraelectric and ferroelectric capacitors, diffusion barriers as part of multi dielectric layers, and methods for end point detection in multi dielectric stack plasma etching. Moise is used in the outstanding Office Action to show that annealing the metal layer (type IVB, Zirconium) in a plasma of krypton and oxygen is known in the art. Applicant respectfully submits that Moise does nothing to cure the deficiencies in the suggested combination of prior art discussed above, such as the dielectric material oxidation and the absence of a low k dielectric adjacent to the high k dielectric. Applicant submits that the cited references, whether taken alone or in any combination, neither describe nor suggest all of the features of the present claims, as discussed above with reference to the prior rejections. Therefore, Applicant respectfully requests withdrawal of this rejection.

Claims 29 and 37 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Maiti in view of admitted prior art and Park, Brasen, and Ma, and further in view of Moise. Applicant respectfully traverses this rejection.

The features of all of the cited references have been discussed above. The use of Moise to show annealing of the metal layer in a plasma of Krypton and oxygen has been discussed above. The same arguments as used above still apply. Therefore, even assuming that one of ordinary skill in the art would somehow be motivated to make the suggested combination, this combination of references still does not disclose or describe the features of the present claims. For example, the suggested combination of references still does not describe at least the claimed feature of oxidation of low temperature electron beam deposited essentially pure single metal layer on the semiconductor. Thus, the references' structure is different from the claimed

structure. The claimed references also fail to teach the reliability and electrical benefits described in the present application as a result of the claimed structure and method of making the structure. Moreover, as discussed above, the problems with the silicon nitride layer are discussed in Maiti's specification, thus showing that the problem was understood by Maiti, and still the teachings of Maiti do not disclose the claimed arrangement that solves this very problem.

Therefore, Applicant respectfully requests withdrawal of this rejection.

CONCLUSION

Applicant respectfully submits that the claims are in condition for allowance, and notification to that effect is earnestly requested. The Examiner is invited to telephone Applicant's attorney David Suhl at 508-865-8211, or the undersigned attorney at (612) 373-6951 to facilitate prosecution of this application.

If necessary, please charge any additional fees or credit overpayment to Deposit Account No. 19-0743.

Respectfully submitted,

KIE Y. AHN ET AL.

By their Representatives,

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Date Sept. 29, 2004

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CERTIFICATE UNDER 37 CFR 1.8: The undersigned hereby certifies that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail, in an envelope addressed to: MS Amendment, Commissioner of Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on this 29th day of September, 2004.

Amy Moriarty
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